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Background of the MNGD Project

Rural feeder roads, an important element of infrastructure for the lives of rural residents, have long been underfunded. With the goal of providing an accessible road network, the Ethiopian government developed unpaved roads by utilizing community-based labor forces. In this way, Ethiopia was able to achieve a large improvement in terms of rural accessibility over the past 10 years. However, several challenges regarding the development of unpaved roads still exist. Among many other challenges, a problematic type of soil known as black cotton soil presents a challenge to road engineers in Ethiopia. In general, earth and gravel roads easily deteriorate as a result of traffic and rainfall. Black cotton soil causes roads to become even less durable because of its high swelling and shrinkage characteristics. The MNGD project aims to develop a plant-derived soil additive that stabilizes such problematic soils and design operational models of construction for unpaved roads. The expected outcome is a reduction in related construction, rehabilitation and maintenance costs.

A reduction in costs alone may not be sufficient to solve the problem of the underfunding of rural feeder roads without the development of rural road appraisal processes that integrate unquantifiable benefits. Often times, investment decision-making is conducted in an unsystematic manner, leading to a sentiment of unfairness among communities. In the following sections, I will examine how traditional road assessments have assessed benefits and costs as well as the criteria applied by the Ethiopian Roads Authority (ERA).

Traditional Road Project Appraisal Methods and New Appraisal Methods

Traditionally, road infrastructure projects have been assessed using cost-benefit analysis in which the main benefits are usually considered to be transportation

cost savings. Transport cost savings consist of the transportation costs saved because of improved road connections under the current traffic volume ("normal" traffic savings) and potential transport costs saved for any additional traffic volume generated ("generated" traffic savings). This analysis method is called the consumer surplus approach and it was applied to highway construction projects for which the traffic volume was high and stable, making the transport cost savings benefits easy to calculate. However, according to this definition of benefits, investment in rural roads characterized by a low volume of traffic has been a lower priority. Since the 1970s, a new approach has been developed for rural feeder road investment appraisal that integrates the benefits of the added agricultural income derived from higher farmgate prices and lower input costs (van de Walle, 2002).

The producer supply approach was developed to integrate as a benefit component of the growth in agricultural production made possible by rural road investment. The producer supply approach analyzes farm-level benefits derived from the improved farmgate and input prices resulting from reduced transport costs (Carnemark et al., 1976). Sufficient attention should be paid to the possibility that transport cost savings might not be passed on to the agricultural producers but actually absorbed by middlemen and marketing boards that control output prices and transport services. In the consumer surplus approach, the cost component consists of initial road construction and rehabilitation expenditures and annual road maintenance expenditures for their expected economic lives. In the case of the producer supply approach, the cost of other complementary investments, such as agricultural extension services and annual agricultural production costs (i.e., labor, equipment, water) for major crops, are estimated and added to costs (Beenhakker & Chammari, 1979). Similarly, not only transporters' benefits, but also agricultural producers' benefits from added value of output sale are included into the benefit component.

The aforementioned approaches place an emphasis on economic efficiency and still lack sufficient concern for equity and social welfare (van de Walle, 2002). For example, the value of non-market benefits, such as improved access to schools and healthcare services, as well as the risk insurance benefits derived from linking isolated villages to the transportation network, are not yet assessed, which ultimately leads to the underfunding of rural road projects. Since those benefits are likely to accrue to the poorest in society, the omission of such unmeasurable benefits might lead to public transportation investment against the poor. Poverty-focused, hybrid methods have been developed since the 1990s but their criteria

are still crudely defined.

Ethiopia Road Sector Projects

We will examine how road sector development evolved and assess related efficiency and equity concerns in Ethiopia. The government of Ethiopia first implemented the Road Sector Development Program (RSDP) in 1997. Currently in its fifth phase, RSDP IV (2015–2020) has been implemented on the ground. The ERA uses five criteria for the preliminary selection of new road construction projects and determines the final project selection decisions by conducting a cost-benefit analysis (Ethiopian Roads Authority, 2015). The five criteria used for preliminary selection consist of the following elements. Priority is accorded to roads that:

(i) lead to areas with economic development potential (20%);

(ii) lead to surplus food crops and cash crop growing areas (20%);

(iii) link towns (20%);

(iv) provide access to large and isolated population centers (30%); and

(v) improve accessibility to emerging regions (i.e., Gambella, Benishangul-Gumuz, Afar, and Somali) and enable the balanced development of all regions in the country (10%).

Economic potential (criteria (i) and (ii)) and social equity (criteria (iv) and (v)) are prioritized with an equal weight of 40%. Criterion (v) specifically refers to regions characterized by lower network connection and aims to redress existing inequalities in road accessibility (Shiferaw et al., 2015).

Similarly, five criteria are used for the preliminary selection of road upgrading projects. Priority is accorded to roads that:

(i) have high traffic (30%);

(ii) have better network connectivity (20%);

(iii) are in poor condition (20%);

(iv) connect emerging towns with investment potential (10%); and

(v) link neighboring countries (20%).

In the case of road upgrading projects, 50% of the priority is given to roads that have a high potential to break down in the near future and for which a large maintenance burden is expected (criteria (i) and (iii)). The remaining priority is accorded to improving efficiency and economic potential with no explicit reference to social equity. After prioritizing road projects based upon these five criteria, final project selection is conducted using the producer surplus approach or the Highway Development and Management Model (which focuses on the consumer surplus), depending on road type (Ethiopian Roads Authority, 2015). This selection process applies to road project proposals submitted by regional states.

Rural feeder roads are administered by *woreda* (district) governments and feature different selection criteria. Since RSDP IV (2010–2015), rural feeder roads have been developed with the goal of connecting all *kebeles* (villages) with all-weather roads under the auspices of the Universal Rural Road Access Program (URRAP) sub-program. In the URRAP, funding is provided to Regional Roads Authorities (RRA), and RRAs allocate funds to *woreda* road desks. In the case of the Regional Roads Authority of Southern Nations, Nationalities, and Peoples' Region (SNNPR), it allocates URRAP funds equally among all *woredas* and each *woreda* road desk applies their own priority selection criteria in choosing specific areas for road construction. From the hearing at the Zone Road Authority, *woreda* governors pay keen attention to equity concerns when developing rural road networks. However, the co-existence of federal-level asphalt roads and poor-standard undeveloped trails in close proximity sometimes induces a sentiment of unfairness. In addition, feeder road construction in severe terrain is heavily constrained by limited funding. The URRAP places a relatively large emphasis on equity concerns, but actual equity provision in terms of road construction selection requires transparency in the selection criteria.

Impact of the RSDP and the URRAP

Project appraisal takes place during the project selection period when the costs and benefits are estimated. Once public investment ends, the actual impact is evaluated to check the impact on the ground with a strong emphasis on the identification of causal links. A road is not randomly placed and this placement is often heavily biased toward inherent economic potential, making it difficult to distinguish between the effect of bias and the actual impact of the road. Yet, some

association with a reduction in poverty and an increase in income is observed in countries with low road density such as Ethiopia, Uganda, Tanzania, Madagascar, and Peru (Hine et al., 2016).

In the case of Ethiopia, both trunk roads and rural feeder roads seem to have large positive effects on reducing the vulnerability to poverty and the development of local industry. For instance, Nakamura et al. (2019) found that the communities connected with URRAP feeder roads cope better with drought shocks. Similarly, Hill & Fuje (2018) discovered that the negative impact of drought on consumption was largely alleviated in areas in which road travel time was shortened. Abay & Hirvonen (2017) observed that in the Tigray region, children's malnutrition during lean times was largely alleviated in areas characterized by better market access. These results are consistent with the notion that crop price fluctuations are improved by market integration. Not only is crop price fluctuation reduced, improved road access is also expected to reduce the costs of acquiring inputs and transporting agricultural outputs and to permit community access to alternative non-farm employment. Consistent with these expected positive impacts on incomes, Dercon et al. (2009) indicated that the provision of all-weather roads in rural Ethiopia reduced poverty by 6.9% and increased consumption growth by 16%. Shiferaw et al. (2015) found that RSDP road development positively influenced the entry of manufacturing firms into those emerging regional cities that were not previously located in the manufacturing center.

MNGD Project Goals for Road Sector Development in Ethiopia

Considering the great potential benefits expected from rural feeder road development in Ethiopia, the prospect of developing a soil additive through the MNGD project is quite promising because it can provide durable, unpaved road networks to rural communities. Currently, unpaved earth and gravel roads are developed through labor-based technology under the URRAP, but their durability is in question. The technology developed through MNGD projects will be applied to the construction and rehabilitation of these unpaved roads. The new soil additive has the potential to reduce maintenance and construction costs and relax the budget constraints under which *woreda* road authorities operate, strengthening their capacity to provide improved road services to villages that have active community participation and a great desire for better roads. However, the concerns over transparency regarding road investment selection nonetheless

remain and should be tackled in collaboration with local road authorities.

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